

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (currently amended): A process for producing an ester, comprising reacting a feed of a carboxylic acid and ethylene in the presence of an acid catalyst and in a vapor phase to provide products; and recycling a portion of the products to the feed to form a combined feed and recycle stream; wherein the concentration of olefin selected from the group consisting of trans-2-butene, cis-2-butene and 1-butene in the combined feed and recycle stream is 10,000 ppm or less in terms of the molar ratio to the total of the olefin and ethylene;

wherein the concentration of the olefin in the combined feed and recycle stream is controlled by removing the olefin from the recycle stream.

2. (previously presented): The process as claimed in claim 1, wherein the concentration of the olefin in the combined feed and recycle stream is 5,000 ppm or less in terms of the molar ratio to the total of the olefin and ethylene.

3. (previously presented): The process as claimed in claim 2, wherein the concentration of the olefin in the combined feed and recycle stream is 1,000 ppm or less in terms of the molar ratio to the total of the olefin and ethylene.

4. (canceled).

5. (currently amended): A process for producing an ester, comprising reacting a feed of a carboxylic acid and ethylene in the presence of an acid catalyst and in a vapor phase to provide products; and recycling a portion of the products to the feed to form a combined feed and recycle stream; wherein the concentration of olefin equivalent, selected from the group consisting of saturated alcohols having 4 or more carbon atoms, esters of a carboxylic acid and a saturated alcohol having 4 or more carbon atoms, and saturated ethers having 5 or more carbon atoms, which yields trans-2-butene, cis-2-butene or 1-butene, in the combined feed and recycle stream is 50,000 ppm or less in terms of the molar ratio to the total of the olefin equivalent and ethylene;

wherein the concentration of the olefin in the combined feed and recycle stream is controlled by removing the olefin from the recycle stream.

6. (previously presented): The process as claimed in claim 5, wherein the concentration of the olefin equivalent in the combined feed and recycle stream is 25,000 ppm or less in terms of the molar ratio to the total of the olefin equivalent and ethylene.

7. (previously presented): The process as claimed in claim 6, wherein the concentration of the olefin equivalent in the combined feed and recycle stream is 5,000 ppm or less in terms of the molar ratio to the total of the olefin equivalent and the ethylene.

8. (canceled).

9. (currently amended): A process for producing an ester, comprising reacting a feed of a carboxylic acid and ethylene in the presence of an acid catalyst and in a vapor phase to provide products; and recycling a portion of the products to the feed to form a combined feed and recycle stream; wherein the sum of the concentration of olefin selected from the group consisting of trans-2-butene, cis-2-butene and 1-butene and one-fifth the concentration of olefin equivalent in the combined feed and recycle stream is 10,000 ppm or less in terms of the molar ratio to the total of the olefin and olefin equivalent and ethylene;

wherein the concentration of the olefin in the combined feed and recycle stream is controlled by removing the olefin from the recycle stream.

10. (previously presented): The process as claimed in claim 9, wherein the sum of the concentration of the olefin and one-fifth the concentration of olefin equivalent in the combined feed and recycle stream is 5,000 ppm or less in terms of the molar ratio to the total of the olefin and olefin equivalent and ethylene.

11. (previously presented): The process as claimed claim 10, wherein the sum of the concentration of the olefin and one-fifth the concentration of olefin equivalent in the combined feed and recycle stream is 1,000 ppm or less in terms of the molar ratio to the total of the olefin and olefin equivalent and ethylene.

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12. (canceled).

13. (previously presented): The process as claimed in any one of claims 9 to 11, wherein the olefin equivalent comprises at least one compound selected from the group consisting of saturated alcohols having 3 or more carbon atoms, esters of a carboxylic acid and a saturated alcohol having 3 or more carbon atoms, and saturated ethers having 5 or more carbon atoms.

14. (previously presented): The process as claimed in any one of claims 1 to 3, 5 to 7 and 9 to 11, wherein the carboxylic acid and ethylene is reacted in the presence of water.

15. (previously presented): The process as claimed in any one of claims 1 to 3, 5 to 7 and 9 to 11, wherein the carboxylic acid is at least one of lower aliphatic carboxylic acids having from 1 to 4 carbon atoms.

16. (previously presented): The process as claimed in any one of claims 1 to 3, 5 to 7 and 9 to 11, wherein the acid catalyst comprises at least one compound selected from heteropolyacids and heteropolyacid salts.

17. (original): The process as claimed in claim 16, wherein the heteropolyacid comprises at least one compound selected from the group consisting of silicotungstic acid,

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phosphotungstic acid, phosphomolybdic acid, silicomolybdic acid, silicovanadotungstic acid, phosphovanadotungstic acid, phosphovanadomolybdic acid, molybdotungstosilicic acid and molybdotungstophosphoric acid.

18. (original): The process as claimed in claim 16, wherein the heteropolyacid salt comprises at least one compound selected from the group consisting of lithium, sodium, potassium, cesium, magnesium, barium, copper, gold, gallium and ammonium salts of heteropolyacids.

19. (previously presented): The process as claimed in claim 13, wherein the carboxylic acid and ethylene is reacted in the presence of water.

20. (previously presented): The process as claimed in claim 13, wherein the carboxylic acid is at least one of lower aliphatic carboxylic acids having from 1 to 4 carbon atoms.

21. (previously presented): The process as claimed in claim 14, wherein the carboxylic acid is at least one of lower aliphatic carboxylic acids having from 1 to 4 carbon atoms.

22. (previously presented): The process as claimed in claim 13, wherein the acid catalyst comprises at least one compound selected from heteropolyacids and heteropolyacid salts.

23. (previously presented): The process as claimed in claim 22, wherein the heteropolyacid comprises at least one compound selected from the group consisting of silicotungstic acid, phosphotungstic acid, phosphomolybdic acid, silicomolybdic acid, silicovanadotungstic acid, phosphovanadotungstic acid, phosphovanadomolybdic acid, molybdotungstosilicic acid and molybdotungstophosphoric acid.

24. (previously presented): The process as claimed in claim 22, wherein the heteropolyacid salt comprises at least one compound selected from the group consisting of lithium, sodium, potassium, cesium, magnesium, barium, copper, gold, gallium and ammonium salts of heteropolyacids.

25. (previously presented): The process as claimed in claim 14, wherein the acid catalyst comprises at least one compound selected from heteropolyacids and heteropolyacid salts.

26. (previously presented): The process as claimed in claim 25, wherein the heteropolyacid comprises at least one compound selected from the group consisting of silicotungstic acid, phosphotungstic acid, phosphomolybdic acid, silicomolybdic acid, silicovanadotungstic acid, phosphovanadotungstic acid, phosphovanadomolybdic acid, molybdotungstosilicic acid and molybdotungstophosphoric acid.

27. (previously presented): The process as claimed in claim 25, wherein the heteropolyacid salt comprises at least one compound selected from the group consisting of lithium, sodium, potassium, cesium, magnesium, barium, copper, gold, gallium and ammonium salts of heteropolyacids.

28. (previously presented): The process as claimed in claim 15, wherein the acid catalyst comprises at least one compound selected from heteropolyacids and heteropolyacid salts.

29. (previously presented): The process as claimed in claim 28, wherein the heteropolyacid comprises at least one compound selected from the group consisting of silicotungstic acid, phosphotungstic acid, phosphomolybdic acid, silicomolybdic acid, silicovanadotungstic acid, phosphovanadotungstic acid, phosphovanadomolybdic acid, molybdotungstosilicic acid and molybdotungstophosphoric acid.

30. (previously presented): The process as claimed in claim 28, wherein the heteropolyacid salt comprises at least one compound selected from the group consisting of lithium, sodium, potassium, cesium, magnesium, barium, copper, gold, gallium and ammonium salts of heteropolyacids.

31. (canceled).

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32. (currently amended): The process as claimed in claim ~~34~~1, wherein the removal of the olefin from the recycle stream is conducted by solvent absorption, distillation or membrane separation.

33. (previously presented): The process as claimed in any one of claims 5 to 7, wherein the concentration of the olefin in the combined feed and recycle stream is controlled by removing the olefin from the recycle stream.

34. (currently amended): The process as claimed in claim ~~33~~5, wherein the removal of the olefin from the recycle stream is conducted by solvent absorption, distillation or membrane separation.

35. (canceled).

36. (currently amended): The process as claimed in claim ~~35~~9, wherein the removal of the olefin from the recycle stream is conducted by solvent absorption, distillation or membrane separation.